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Satellite & Fibre Communications: A Solution for Africa?

Professor Chris Chatwin,

Engr Lasisi Lawal, Dr Young, Dr Birch – IET –

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Summary

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- Challenges & cost of the Internet in Nigeria
- Global Fibre Optic Backbone
- African Sub-sea Optical Fibre Backbone
- Satellite Option
- Satellite & Wireless Systems
- DWDM in Tanzania

Complexities in Africa

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- Political instability
- Insurgencies
- Poverty
- Unreliable power generation systems
- Very little in the way of planning controls
- Taxes and rights of way

The Cost of the Internet in Nigeria

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- Prevailing price of VSAT bandwidth before NIGCOMSAT-1 (2004 viability assessment)
- Average price paid for 64kbps was $8,340 per year
- 128/1024 kbps bandwidth costs about $2,000 monthly, this implies that estimated 2MB (E1) would cost $3,500 per month or $42,000 yearly
- Comparatively, equivalent capacity of 2Mbps (E1) full circuit on SAT-3 fibre optic cable from Lagos to Europe (Portugal). The only operating cable, was: $144,500 per year by NITEL . NITEL (Nigerian Telecommunications Ltd) is Nigerian Government owned telecommunication company managing the only landing cable in Nigerian Shores (Lagos).

20 hours of local dial-up internet per month in Nigeria is:

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- 500% higher than in India
- 140% higher than in South Africa and Namibia
- About the same as Uganda
- International Internet Connectivity accounts for about 30% of ISP costs
- International Internet Connectivity has two parts:
  a. International leased circuits; over-priced (often grossly)
  b. Global Internet connectivity : rarely identified separately
- Reluctance by operators to disclose information suggests, it is key to competiveness.

20 hours of local dial-up internet per month comparison

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- India: less than $20 comprised of (ISP charges: $3.5; Telephone Call charges $10.2 and Telephone line rental $4.0)

- Nigeria: Over $100 comprised of (ISP charges: $33.0, telephone call charges $80 and Telephone line rental $4.0)

- OECD: less than $40 comprised of (ISP charges: $9.4, telephone call charges $15.1 and Telephone line rental $12.2)

DWDM Optical Fibre Communications - Capacity: 7.1 terabytes per second Dec 2007

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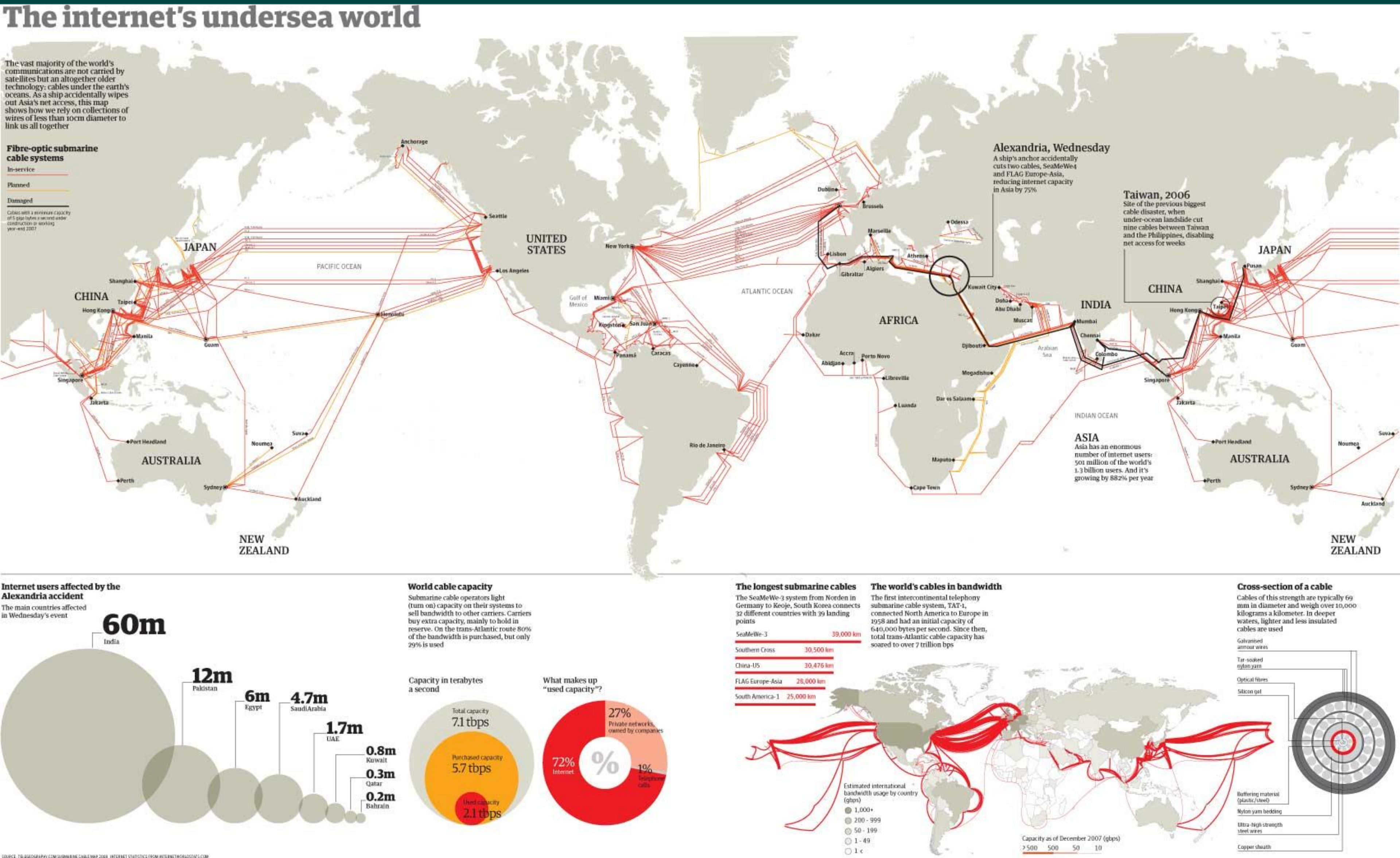
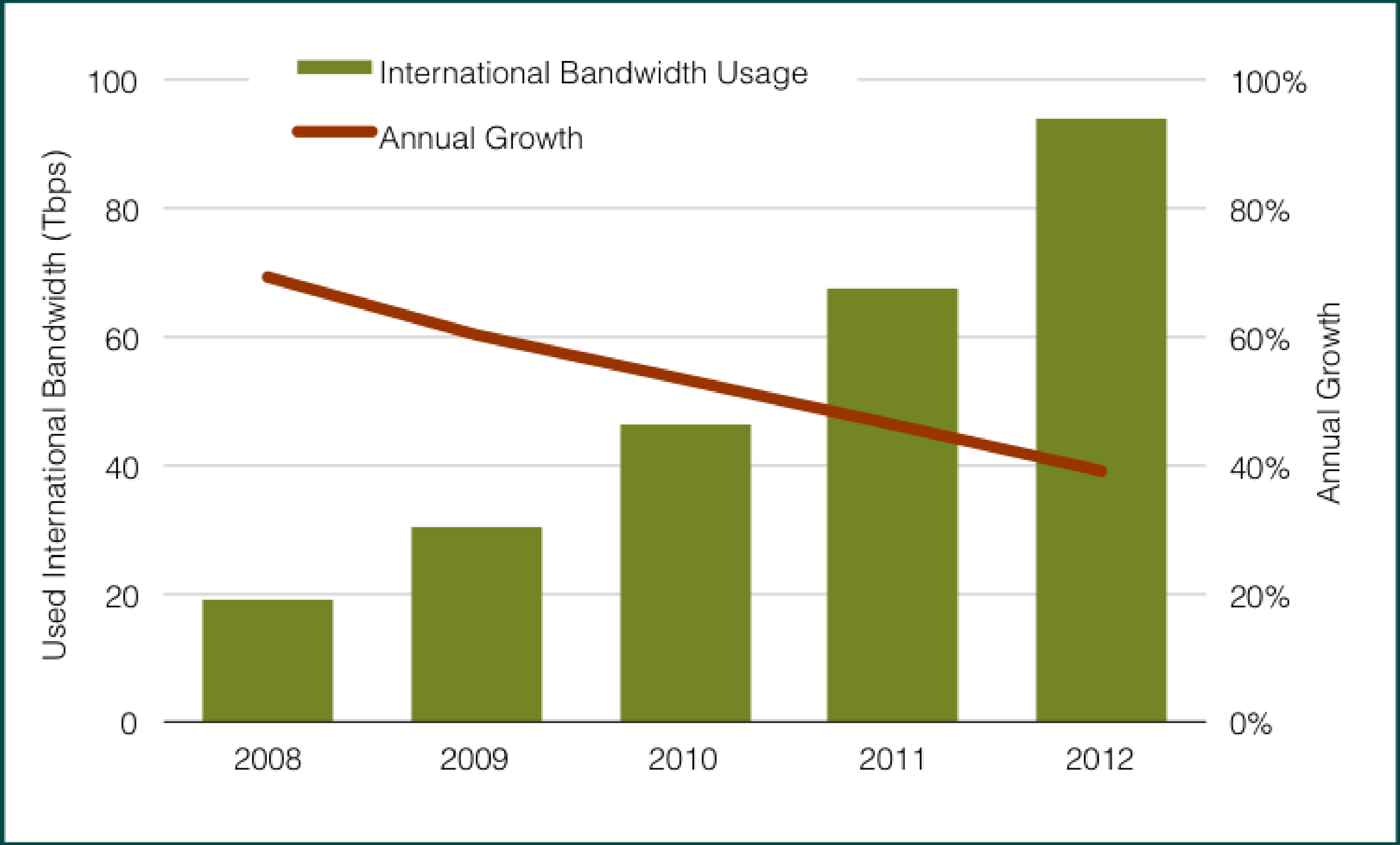


International Bandwidth – Optical Fibre



Arctic Fibre is deploying state of the art technology utilizing 100 gigabit wavelengths to construct a system with a capacity of 24 terabits/s.

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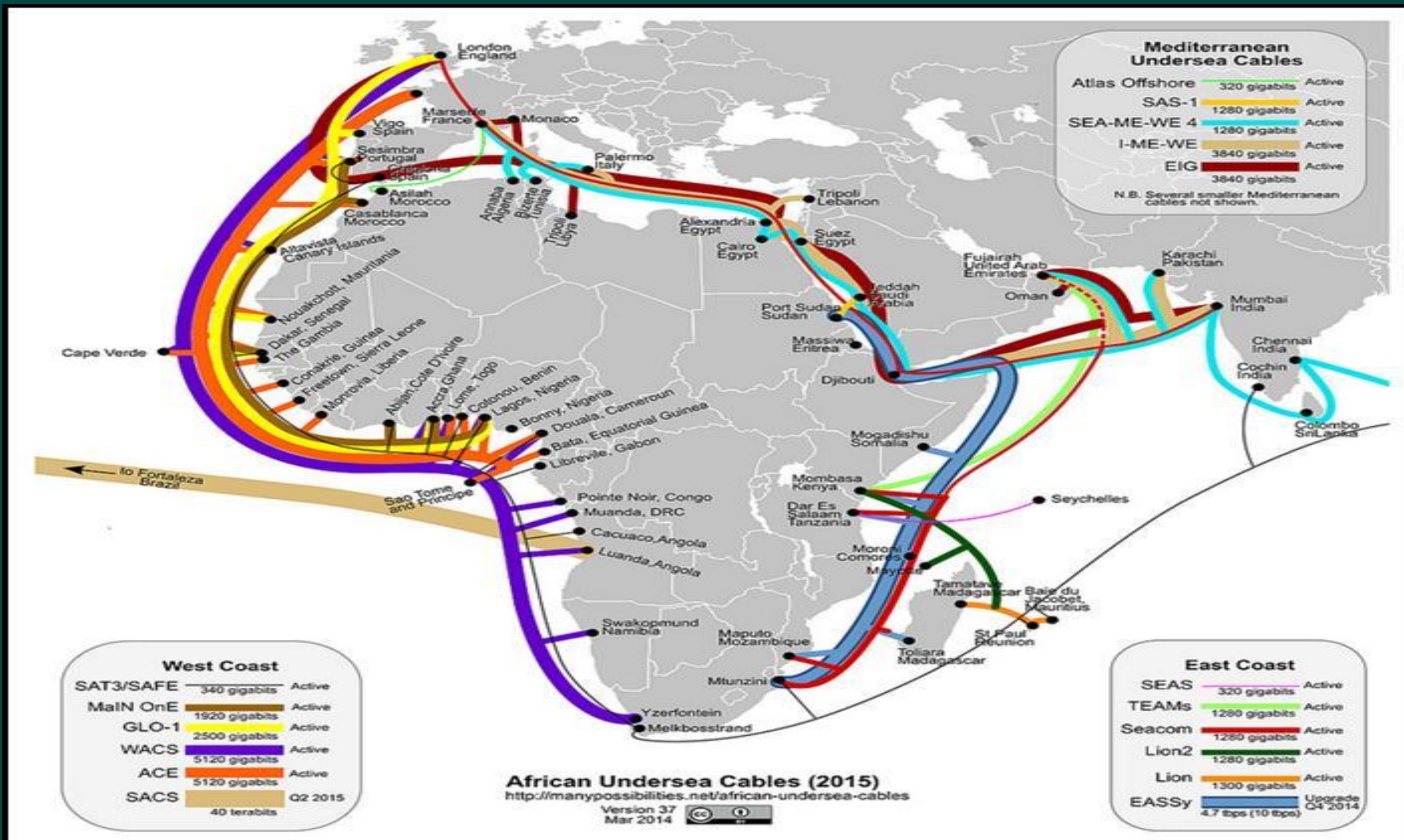
Repeater every 60km

The construction of the system is beginning in May 2014 and is scheduled to be in service in January 2016.

More than adequate terabyte capacity at the shores of Africa



✓WEST COAST: OVER 15TBPS AND 55 TBPS BY 2Q OF 2015

✓EAST COAST: 10.160TBPS AND 15.460 TBPS BY 4Q OF 2014

✓MEDITERRANEAN : 10.56TBPS

Dense Wavelength Division Multiplexing (DWDM)

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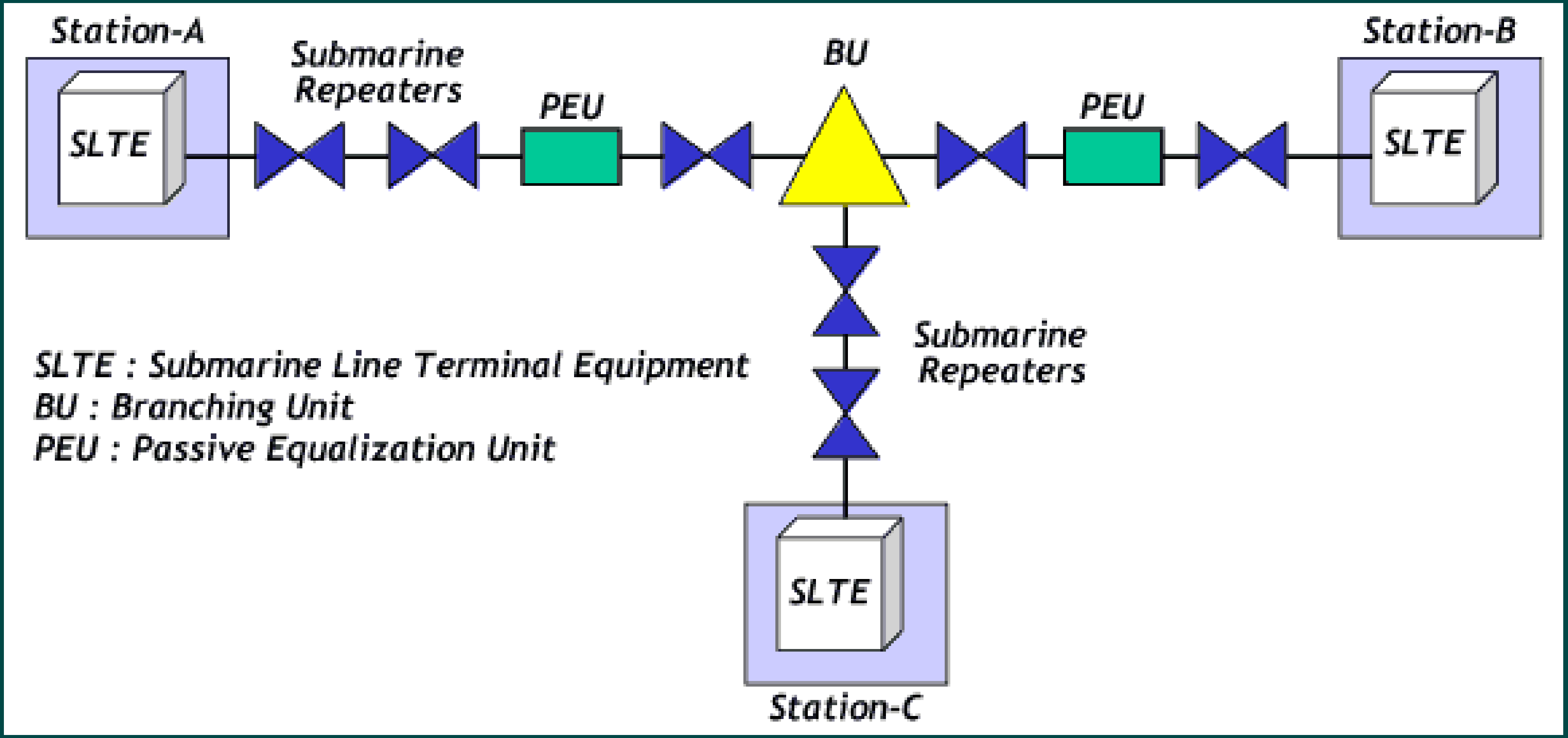
- Optical amplifiers amplify optical signals directly in the optical domain and are capable of simultaneously amplifying multiple signal wavelengths and this has facilitated Dense Wavelength Division Multiplexing (DWDM

- Optical amplifiers are used as repeaters and at the end of each fibre span to boost the power of the DWDM signal channels to compensate for fibre attenuation in the span

Submarine fibre optic cables



Dense Wavelength Division Multiplexing (DWDM)

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- Erbium-doped fibre amplifiers (EDFA) provide gain over a spectral range about 30 nm in width, from about 1530 nm to about 1560 nm
- This permits 40 DWDM signal channels with a separation of 100 GHz and
- 80 channels with a separation of 50 GHz,
- corresponding to 400 or 800 Gb/s, respectively, 10Gb/s OC-192 or STM-64 channels
- In the future, with 40-Gb/s channels, capacities of 1.6 Tb/s (1600Gb/s) for 100-GHz spaced channels will be possible

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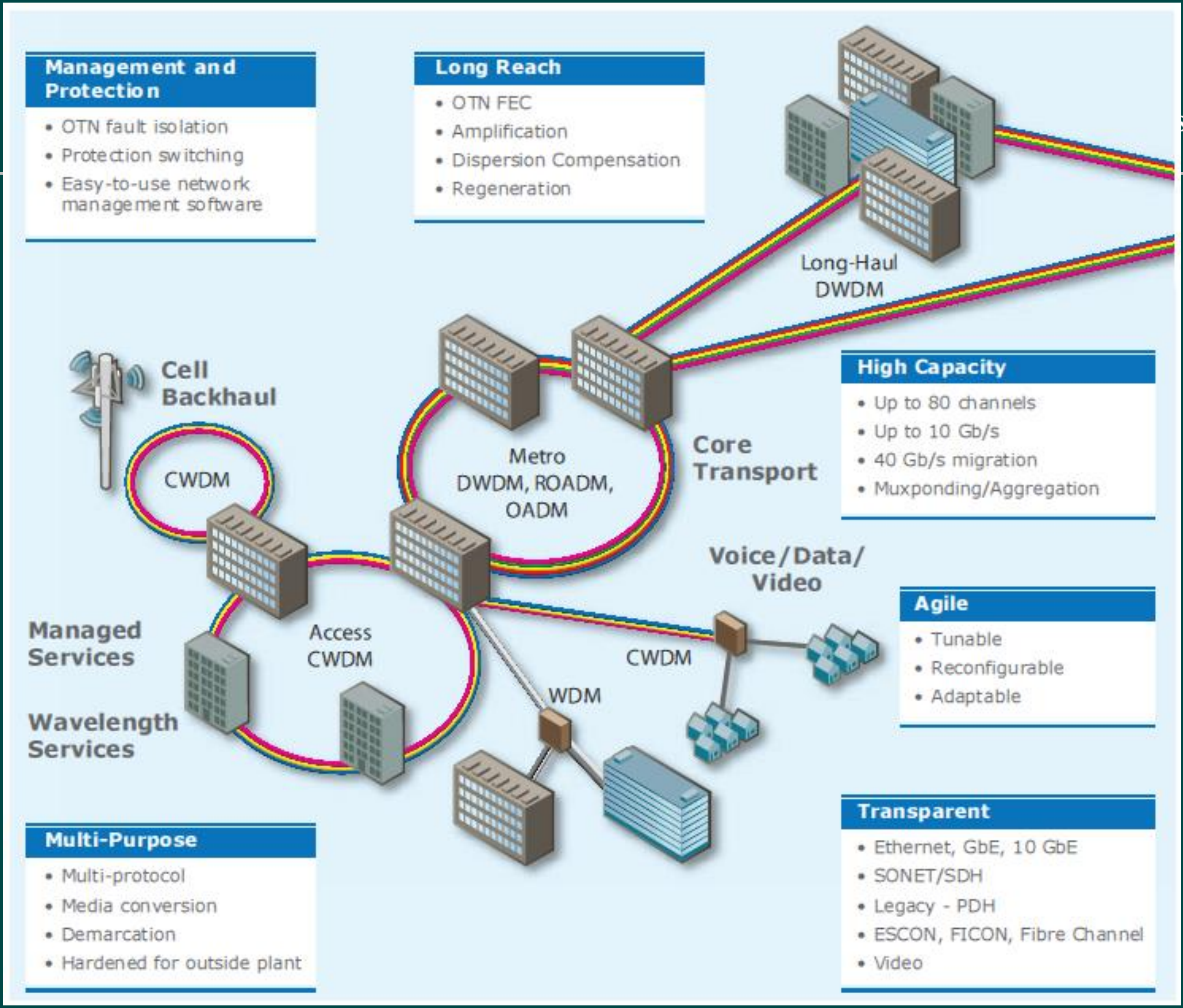
Management and Protection
• OTN fault isolation
• Protection switching
• Easy-to-use network management software
Long Reach
• OTN FEC
• Amplification
• Dispersion Compensation
• Regeneration
Long-Haul DWDM
Cell Backhaul
CWDM
Metro DWDM, ROADM, OADM
Core Transport
High Capacity
• Up to 80 channels
• Up to 10 Gb/s
• 40 Gb/s migration
• Muxponding/Aggregation
Voice/Data/ Video
Agile
• Tunable
• Reconfigurable
• Adaptable
Managed Services
Access CWDM
CWDM
WDM
Wavelength Services
Multi-Purpose
• Multi-protocol
• Media conversion
• Demarcation
• Hardened for outside plant
Transparent
• Ethernet, GbE, 10 GbE
• SONET/SDH
• Legacy - PDH
• ESCON, FICON, Fibre Channel
• Video

Course Wavelength Division Multipexing (CWDM)

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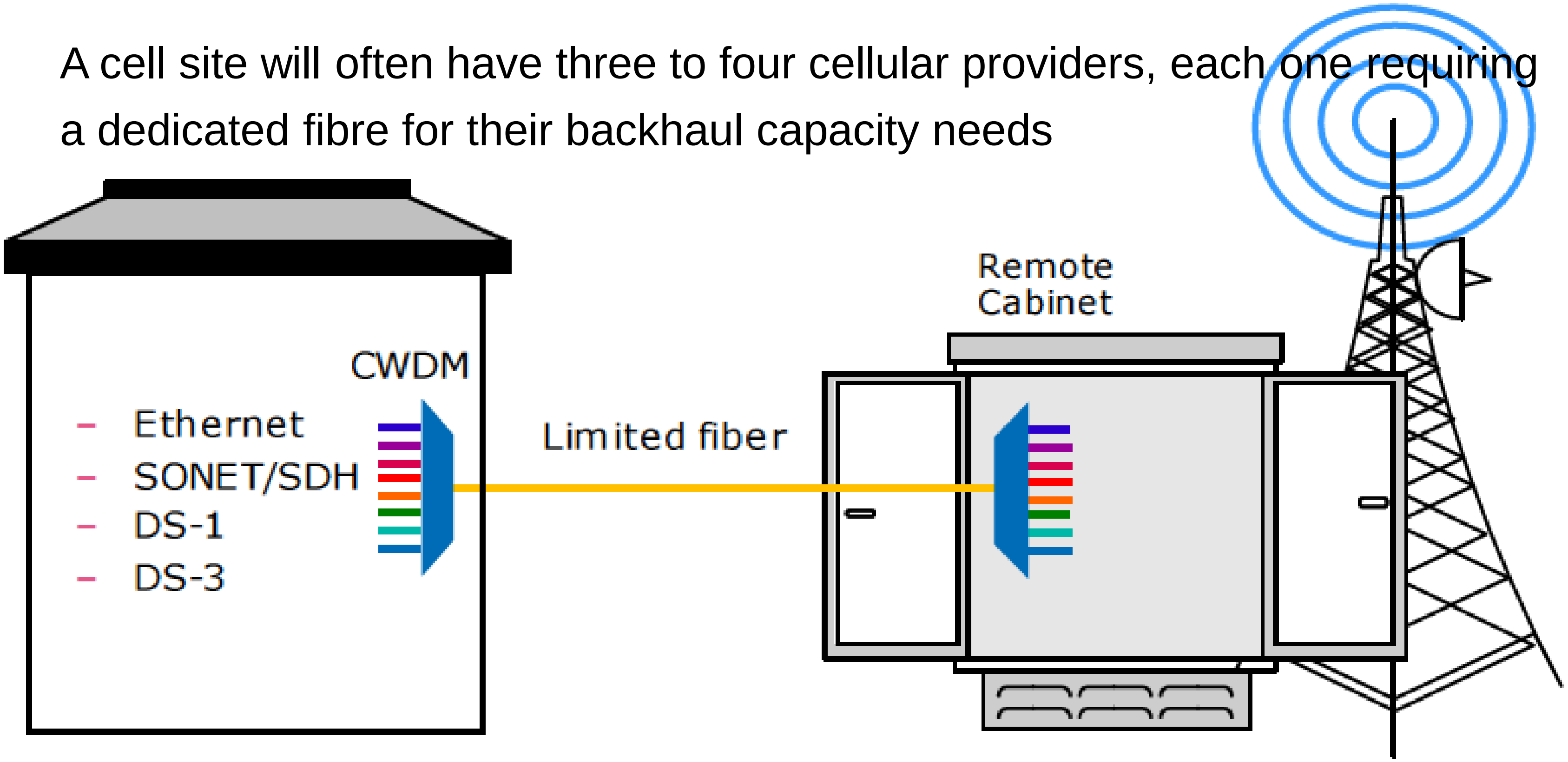
- CWDM systems are medium capacity wavelength division multiplexing systems used over distances up to 80 km (50 miles).
- They are defined by the International Telecommunications Union (ITU) recommendation (standard)
- G.694.2 (2003) as 18 wavelengths spaced 20 nm apart starting at 1271 nm and continuing to 1611 nm.

CWDM - Cellular Backhaul

A cell site will often have three to four cellular providers, each one requiring a dedicated fibre for their backhaul capacity needs



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A single cellular service provider can require 300 Mb/s to 1 Gb/s, eliminating the ability to use a copper facility.

The 9,300 square metre data centre near Frankfurt – requires a reliable power supply

- European data centres consumed 56TWh of electricity in 2007 and in the UK they are responsible for almost three per cent of electricity use.

EADS Astrium Ka-SAT, 6.1 Tonnes at launch, 15 year lifetime, 11 kW

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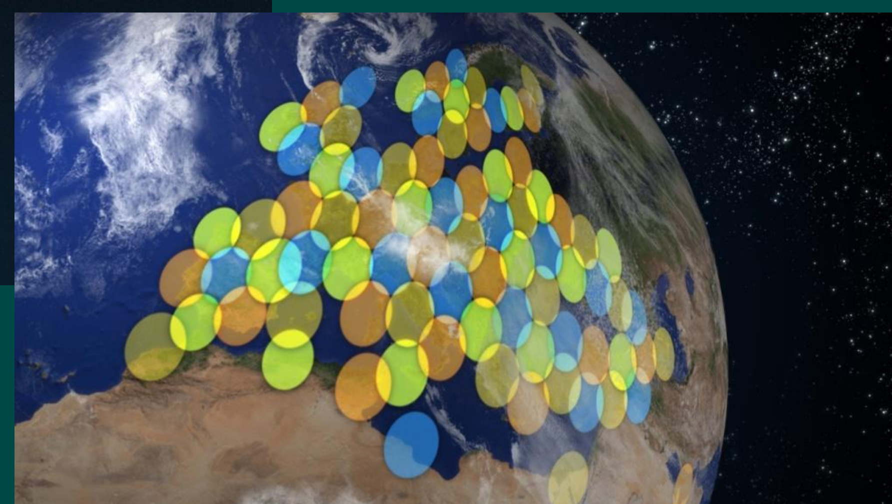
The British military's Skynet 5 satellite system is based on this. The spacecraft is part of a £3.6bn system that will deliver secure, high-bandwidth communications for UK and allied forces.

Eutelsat’s Ka-SAT is the world’s most powerful satellite ever built, with a total capacity of more than 70 Gbps, 35 times the throughput of traditional Ku-band satellites.

KA-SAT will provide ubiquitous complete coverage of Europe and the Mediterranean Basin through its 82 spot beams in Ka-band



ViaSat-1 in the Compact Antenna Test Range (CATR) - Space Systems/Loral

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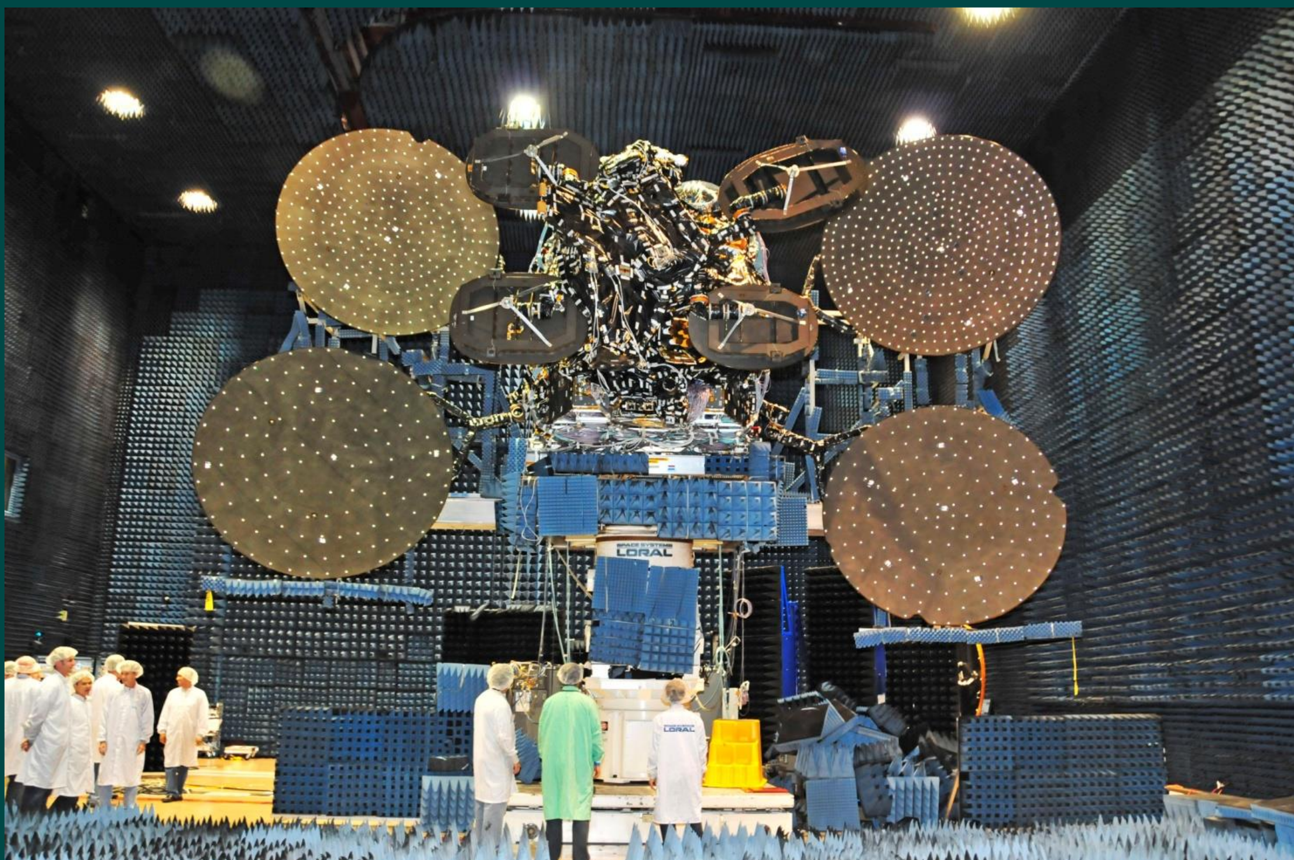
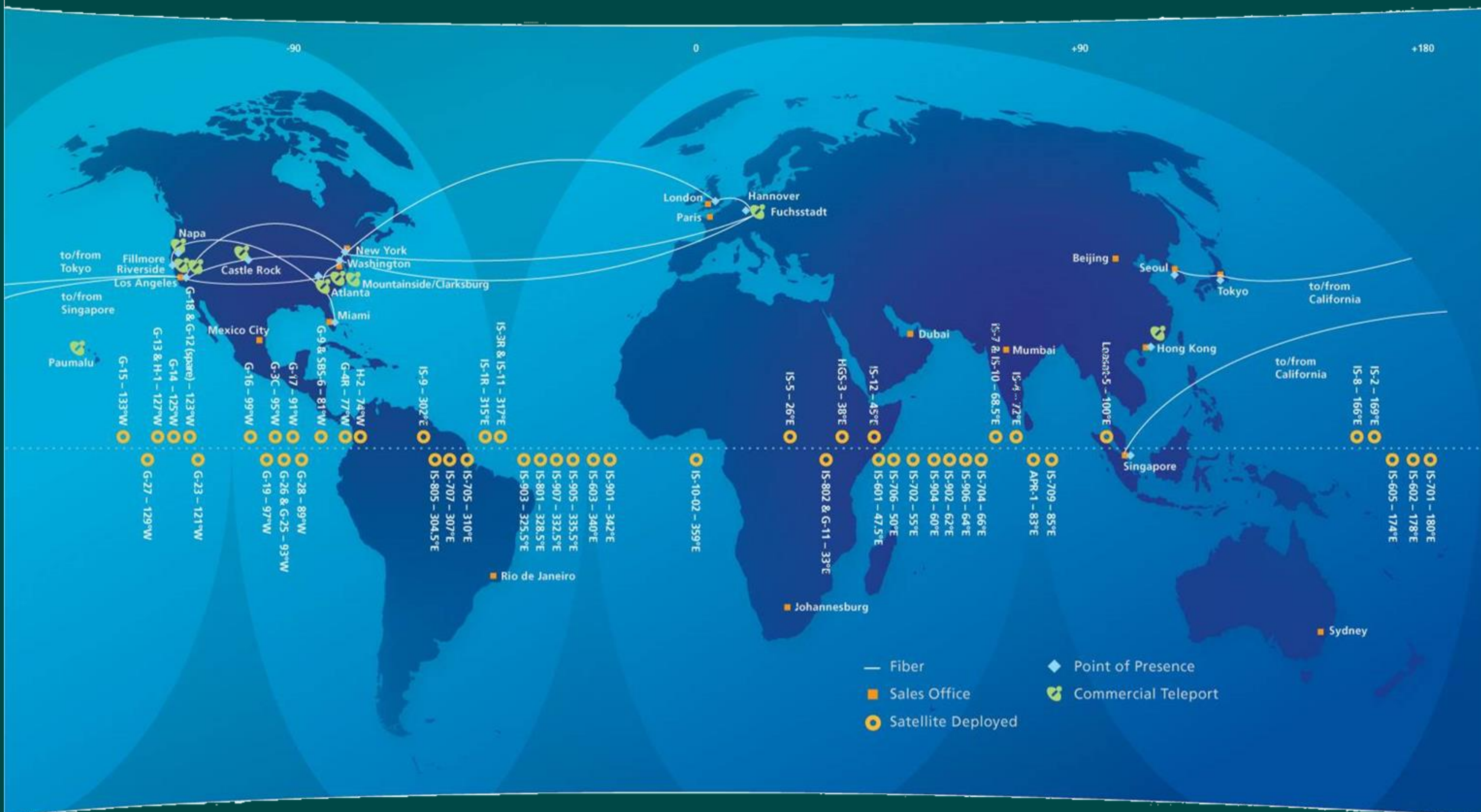


ViaSat-1, which will be positioned at 115.1 degrees West longitude, is expected to provide more than 100 gigabits per second throughput in the Ka band, mostly for use in the West Coast of the U.S. and east of the Texas panhandle. The satellite has 72 spot beams, with 63 in the U.S. and nine over Canada.

The Intelsat Satellite Network



Nigerian Satellite Communication System

- NIGCOMSAT-1 was launched 13th May, 2007 GMT Nigerian time and was de-orbited on 10th November, 2008 due to in-orbit subsystem anomaly – After launch satellite internet prices almost halved, then increased by 50% when it was de-orbited.
- Nigcomsat-1R was launched on 20th December 2011.(GMT) Nigerian time but early hours of 21st December, 2011 Chinese Local Time. Internet connection charges decreased considerably.

Nigcomsat-1R Satellite up to 5 Gbps

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Nigcomsat-1R Satellite – 9kW quad band

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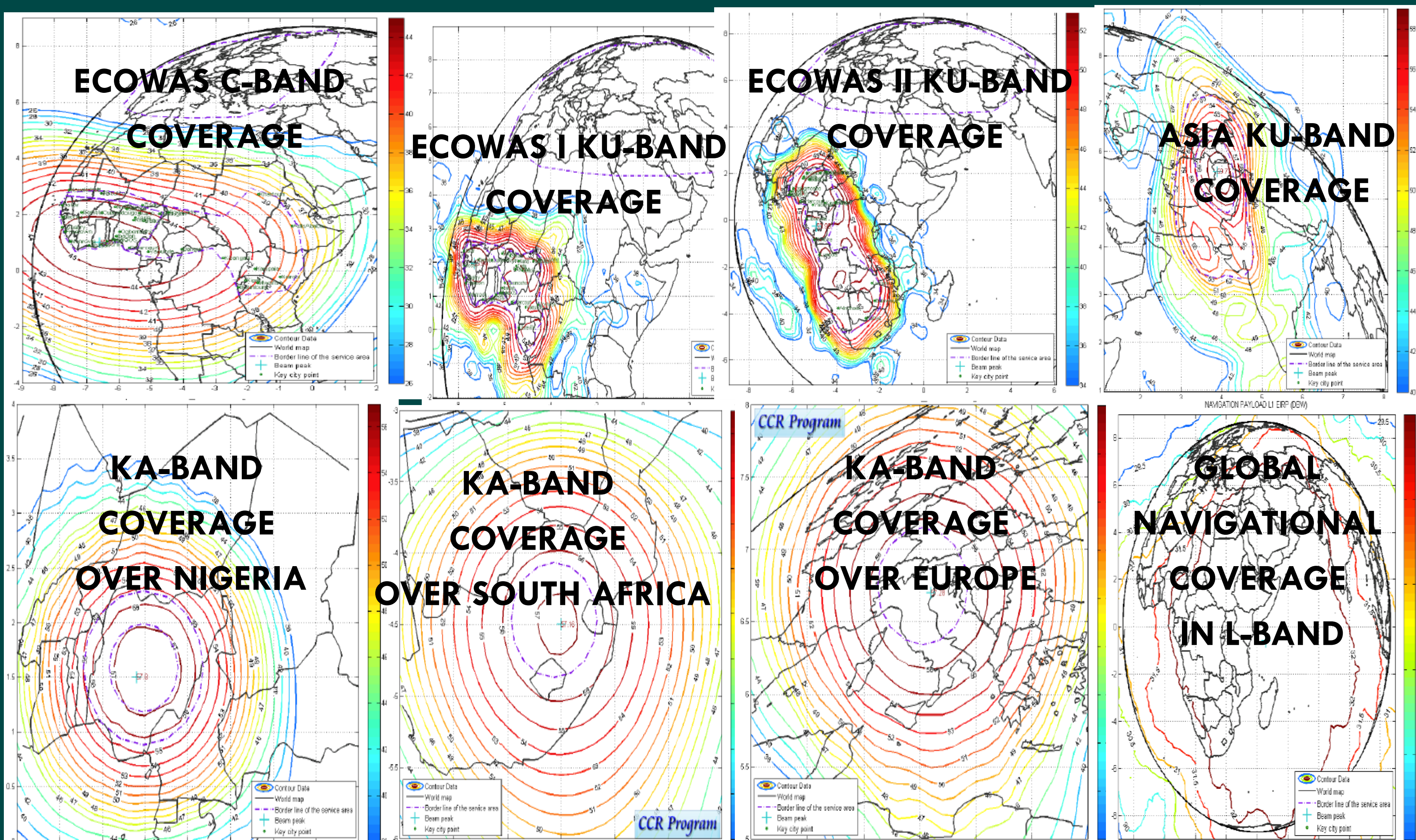
- C-Band Transponder – 4 active transponders - 36MHz
- Ku-Band Transponder – 14 active transponders – 31.5MHz
- Ka-Band Transponder and – 8 active transponders – 120MHz
- L-Band (Navigation) Transponder – 2 active transponders
- Seven (7) Service Antennas
- NigComSat-1R with service life of more than 15 years has a designed life of 22.5 years with more than 0.70 reliability value at the end of its service life.

Nigcomsat-1R Footprints and Coverage



Global Positioning System

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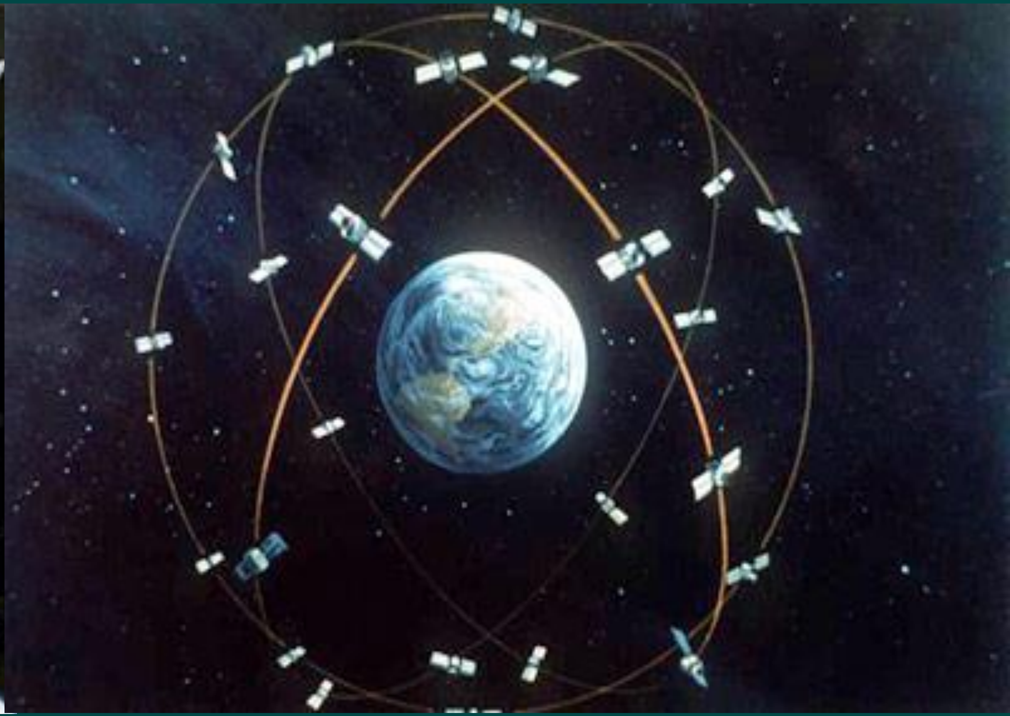

- 24 spacecraft in 12 hour circular orbits, with 3 on-orbit spares. Six circular orbital planes, R=26,560km
- All users with clear view of sky see the minimum of 4, but usually see 6-8
- Augmentation generally not only improves accuracy but integrity, availability and continuity of GPS signals and GNSS signals generally.

ICT Infrastructure in Africa

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- ICT is a development enabler and a prerequisite for a country's transformation into a knowledge-based economy

- This requires ICT readiness, providing a networked ICT infrastructure with ubiquitous access to knowledge and data.

- Africa remains the least wired continent in the world.

ICT Infrastructure in Africa

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- Broadband internet connectivity is grossly inadequate especially in the hinterlands.

- Last mile deployment of broadband through wire-lines requires huge investment, which is hardly affordable when deployed in rural areas.

Broadband Drives GDP

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Table 1 – Research results of broadband Impact on GDP growth

Country	Authors – Institution	Data	Effect
United States	Crandall *et al.* (2007) – Brookings Institution	48 States of US for the period 2003-2005	Not statistically significant results
	Thompson and Garbacz (2008) – Ohio University	46 US States during the period 2001-2005	A 10% increase in broadband penetration is associated with 3.6% increase in efficiency
OECD	Czernich *et al.* (2009) – University of Munich	25 OECD countries between 1996 and 2007	A 10% increase in broadband penetration raises per-capita GDP growth by 0.9-1.5 percentage points
	Koutroumpis (2009) – Imperial College	2002-2007 for 22 OECD countries	An increase in broadband penetration of 10% yields 0.25% increase in GDP growth
High Income Economies	Qiang *et al.* (2009) – World Bank	1980-2002 for 66 high income countries	10% increase in broadband penetration yielded an additional 1.21 percentage points of GDP growth
Low & Middle income economies	Qiang *et al.* (2009) – World Bank	1980-2002 for the remaining 120 countries (low and middle income)	10 % increase in broadband penetration yielded an additional 1.38 in GDP growth

Source:

Economic Impact of broadband - Jobs

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Table 2 – Broadband impact on job creation

Country	Authors – Institution (*)	Objective	Results
United States	Crandall *et al.* (2003) – Brookings Institution	Estimate the employment impact of broadband deployment aimed at increasing household adoption from 60% to 95%, requiring an investment of USD 63.6 billion	• Creation of 140,000 jobs per year over ten years • Total jobs: 1.2 million (including 546,000 for construction and 665,000 indirect)
	Atkinson *et al.* (2009) – ITIF	Estimate the impact of a USD 10 billion investment in broadband deployment	• Total jobs: 180,000 jobs-year (including 64,000 direct and 116,000 indirect and induced
Switzerland	Katz *et al.* (2008b) – CITI	Estimate the impact of deploying a national broadband network requiring an investment of CHF 13 billion	• Total jobs: 114,000 over four years (including 83,000 direct and 31,000 indirect)
United Kingdom	Liebenau *et al.* (2009) – LSE	Estimate the impact of investing USD 7.5 billion to achieve the target of the *"Digital Britain"* Plan	• Total jobs: 211,000 jobs-year (including 76,500 direct and 134,500 indirect and induced)

(*) Note:
ITIF: Information Technology and Innovation Foundation
CITI: Columbia Institute for Tele-Information
LSE: London School of Economics

Source: ITU

Economic Driver

- Africa is in dire need of national, sub-regional and regional carrier of carriers and digital links with cross-border inter-connectivity including intra-city and inter-city metro networks.

- The ICT readiness of any nation is a function of level of networked telecommunications infrastructure, which is a determinant for universal access goals and digital inclusion. The 3As are:

  - AVAILABILITY
  - AFFORDABILITY
  - ACCESSIBILITY

Economic Driver

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- Thus, convergence in communications networks through integrated connectivity is required to bridge the digital hiatus
  - Satellite,
  - Fiber optics,
  - Variants of Wireless Terrestrial Technologies (GSM, CDMA, WiFi, WiMaX, LTE etc

- African leaders and stakeholders have recognized the many challenges that confront their countries and are committed to addressing them through ICT

Economic Driver

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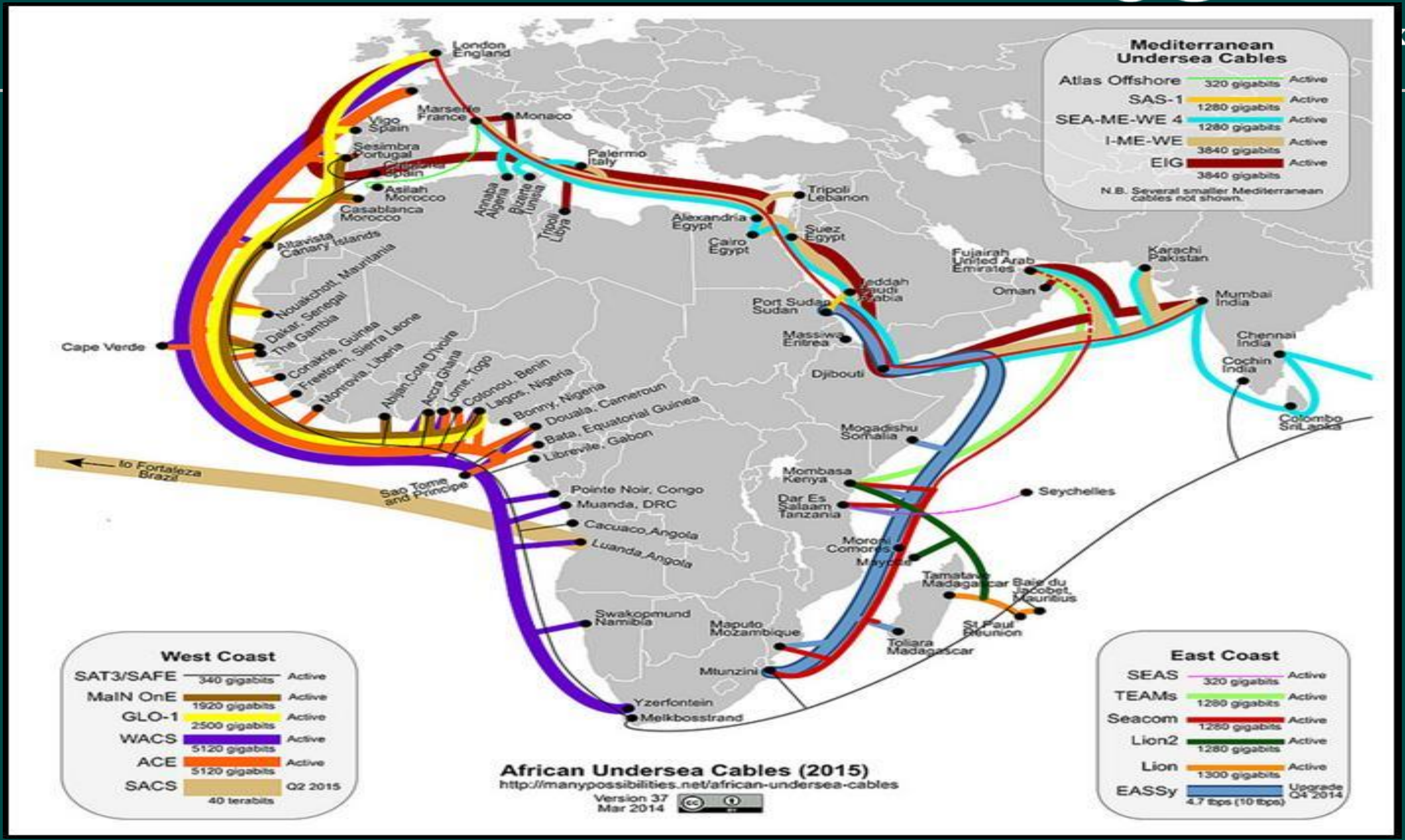
- African Governments and the Organized Private sector recognize that information and communication technologies (ICT) are central to the creation of the emerging global knowledge-based economies.
- The continent is presently served with several terabytes of submarine cable around its coastline, so there are big opportunities

More Than Adequate Terabyte Capacity at the Shores



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The Challenge – Broadband Supply Chain

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International connectivity → National backbone network → Metropolitan access links → Local access network (the last mile)

ABSENCE OF INADEQUATE TERRESTRIAL LAST MILE INFRASTRCTURE IS HINDERING BROADBAND PENETRATION AND UNIVERSAL ACCESS GOALS

Other Challenges

- Right of Way difficulties
- Appropriate corridor and channels for terrestrial last mile largely requires proper urban and regional planning
- Multiple taxation at national, state and local government council levels
- Theft and damage to optical fiber cables especially during road construction and urbanization

Other Challenges

- Anti-competitiveness among operators
- Non-implementation of infrastructural sharing
- Huge capital requirement for deployment of inter-city and Intra-city metro-ring optic fibre
- Affordability of service

Short and Medium Term Strategies

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- To optimize access to information and guarantee universal access in the short and medium term to almost all African inhabitants
- Satellite Communications and wireless systems infrastructure should be given a priority within the ICT framework policy and broadband implementation to complement existing and inadequate terrestrial infrastructure.

Satellite and Wireless

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- ComSats remain strategic national and continental telecommunication infrastructures especially during natural disasters and emergencies.
- As a means of catching up on the infrastructural gap, communications via satellite and terrestrial wireless systems has had significant success in facilitating information technology policies and infrastructures for most African nations especially Nigeria.

Modest Success Stories Based On Wireless Infrastructure

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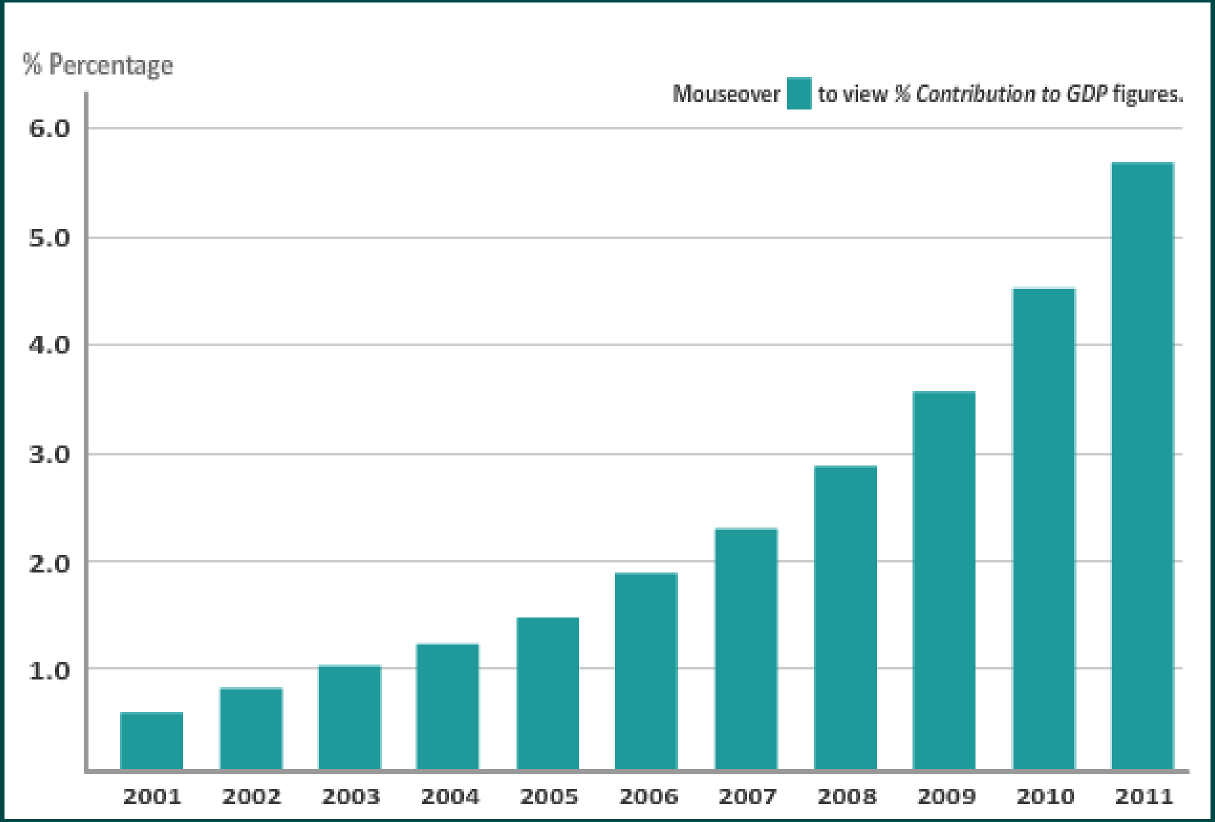

Growing percentage Contribution of Telecoms
To Nigeria's GDP
(2001-2011)

Africa and Wireless Infrastructure Generally

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- Recent findings by the 2010 International Telecommunication Union (ITU) report show that mobile broadband subscriptions and penetration between 2000 and 2009 were increasing more rapidly than fixed broadband subscriptions

- This is a particular trend in the developing nations (emerging economies) of Africa (ITU, 2010).

For Instance, Case Study of the Reality in Nigeria; Accounts For 1/6th Of African Population

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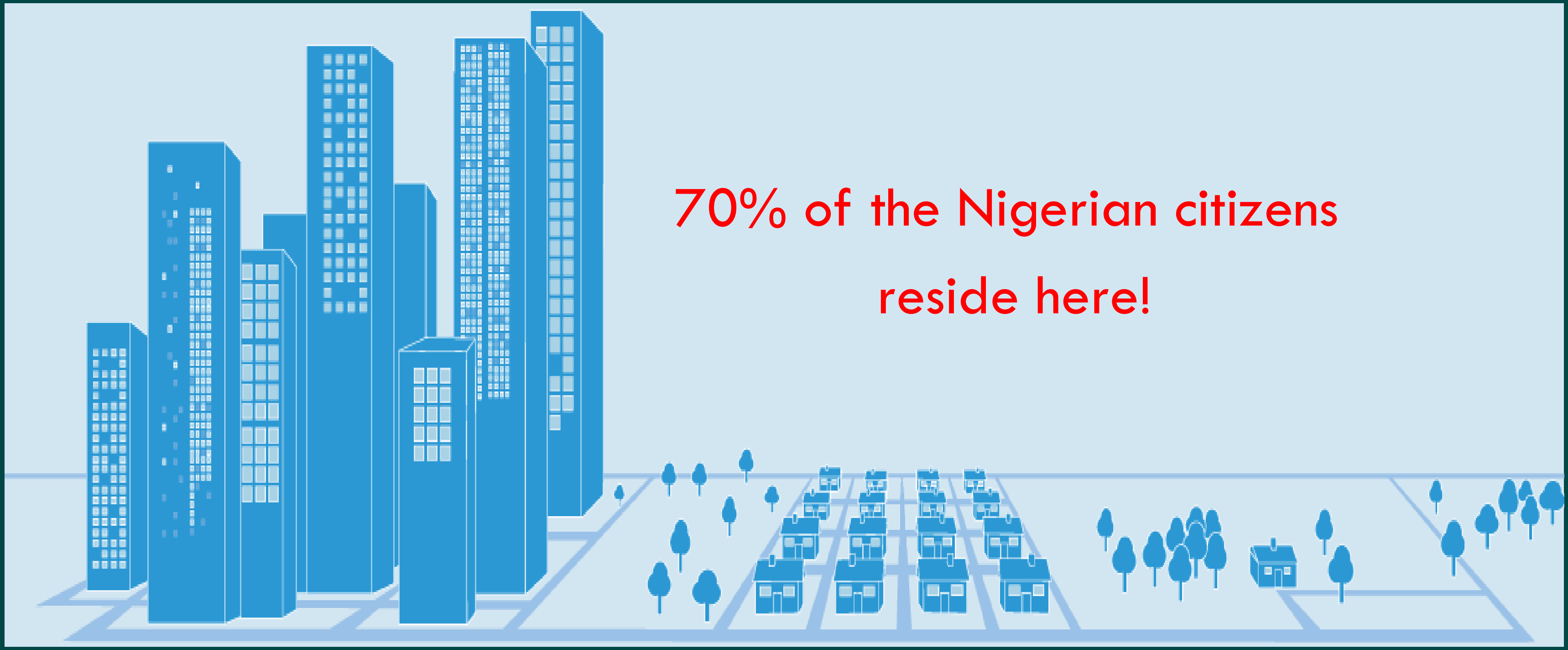
Urban

Suburban

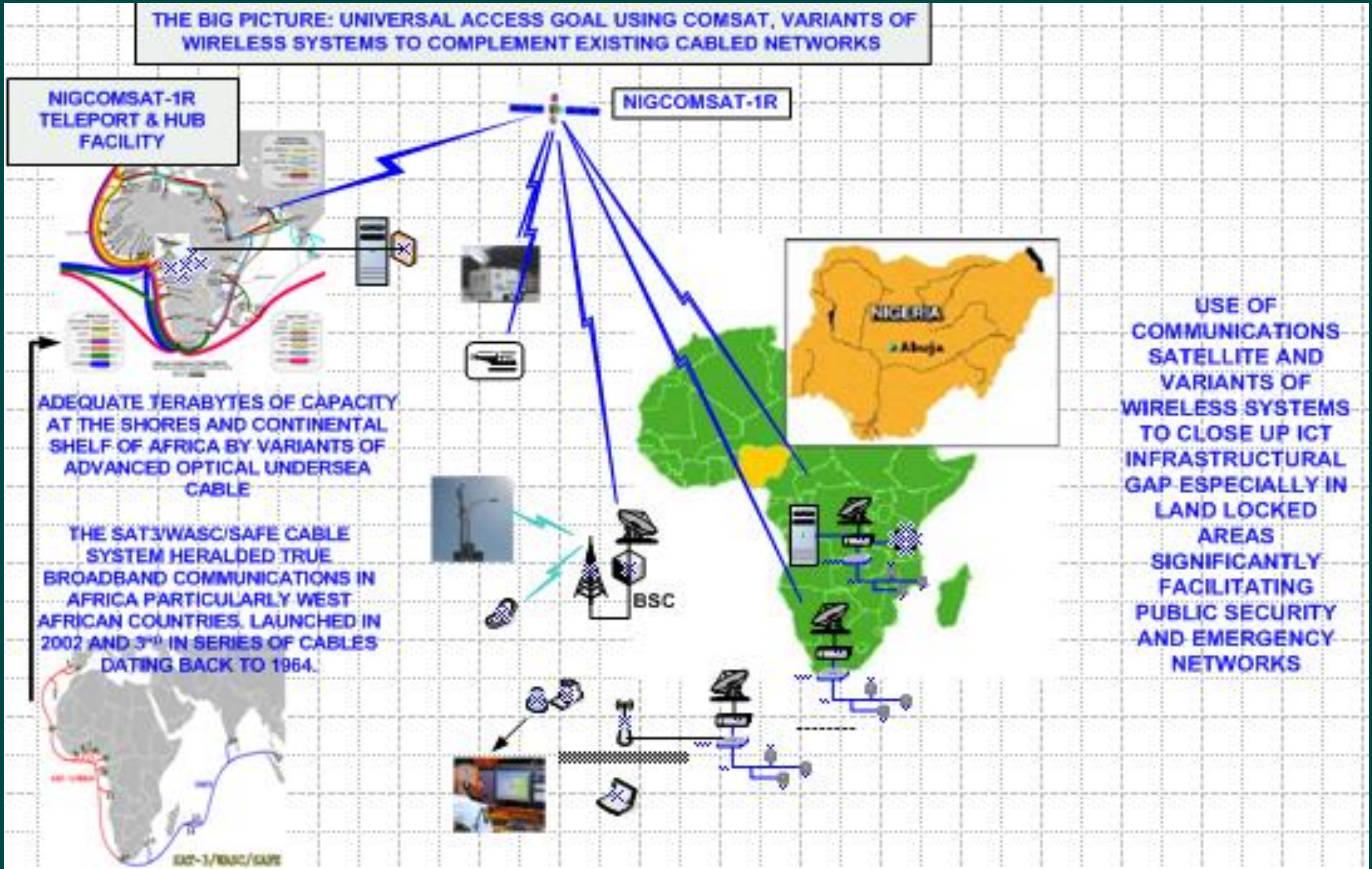
Rural



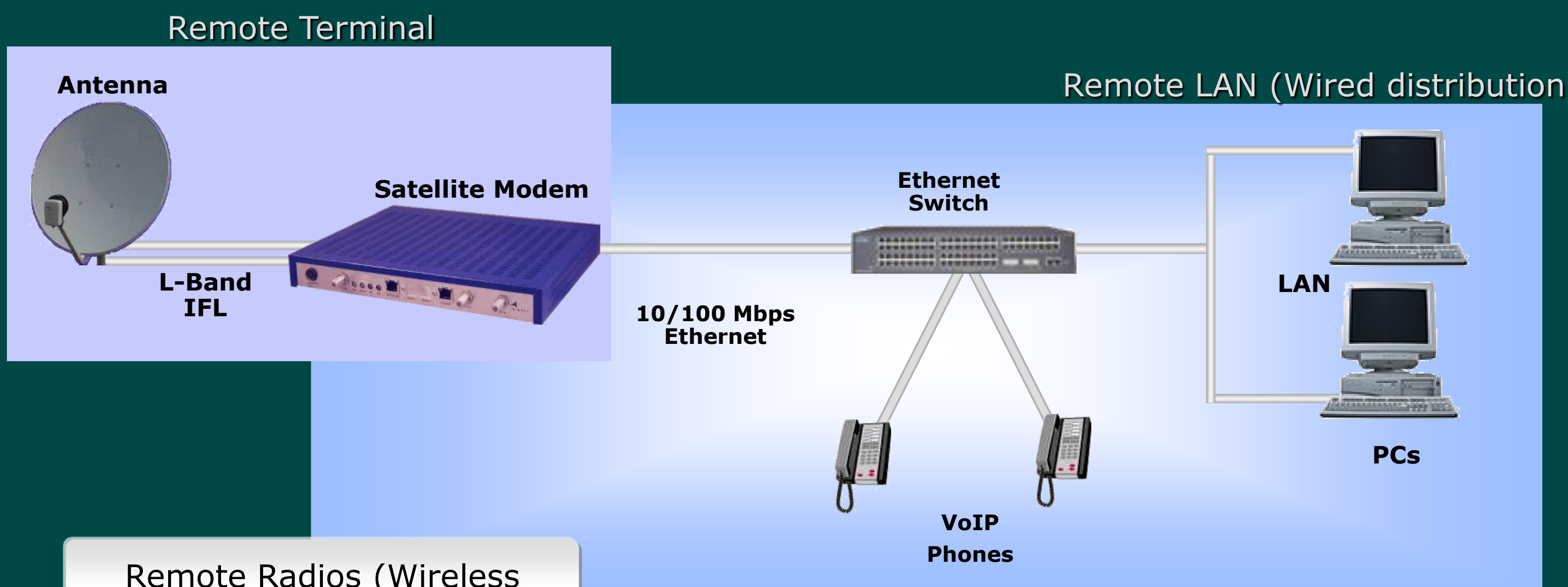
Some degree of Coverage

Minimal Coverage to zero coverage

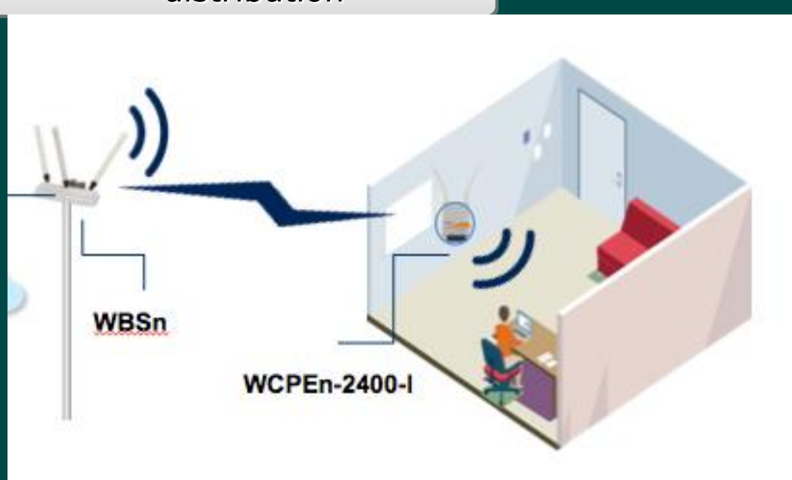
Hybrid Integrated Infrastructure as Solution



Typical Remote Site Configuration as Comsat Last Mile



Remote Radios (Wireless distribution



Communication Satellites as a Bridge to the Infrastructural Gap and Niche in Rural Areas

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- Satellite Communications have a competitive advantage as they complement the present sparsely distributed terrestrial links (fiber optic) and wireless link extensions contributing to accelerated economic growth

- Secure communications for security agencies, socio-economic development, good governance encouraged through transparent processes

Communication Satellites as a Bridge to the Infrastructural Gap and Niche in Rural Areas

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- Promotion of financial and digital inclusion including universal access goals through the ubiquity of COMSATs

- A launch pad for participation in the global knowledge-based economy thus accelerating sustainable growth and development.

- Indigenous satellites serving such interests are NIGCOMSAT-1R, RASCOM-QAF 1R, NILESAT SERIES including international satellite operators such as Intelsat, Eutelsat etc

Services, Solutions & Applications Using Comsats In Africa.

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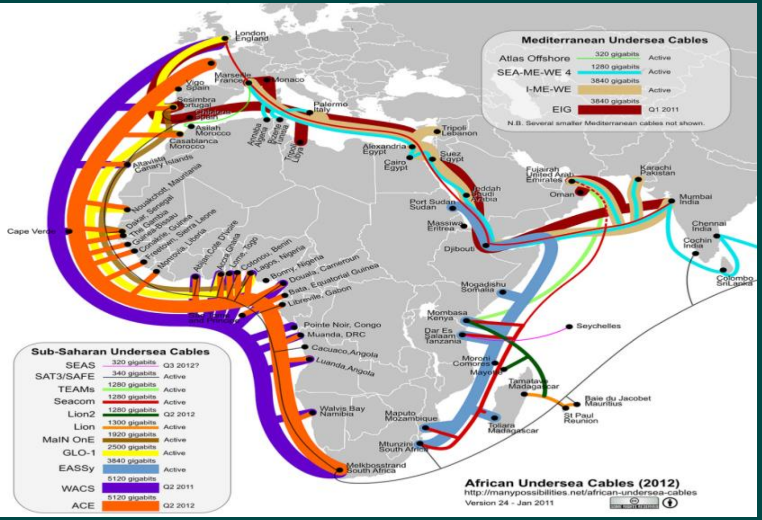
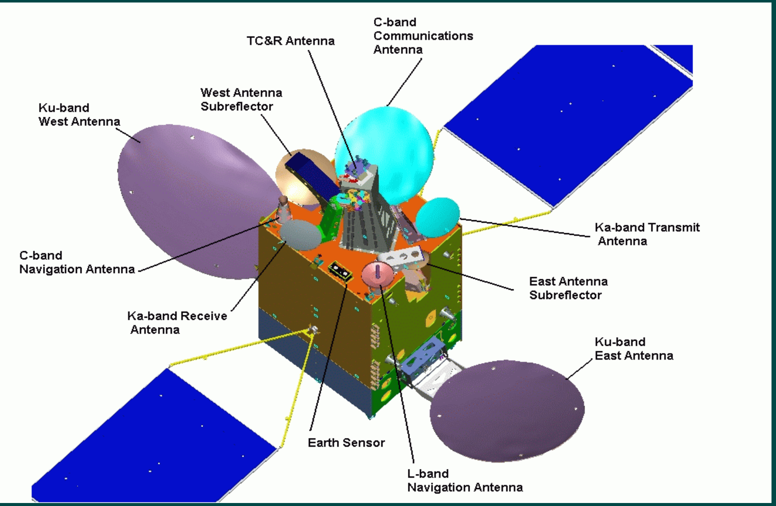
NIGCOMSAT Gateways and hubs are deployed at the coastal areas of the country to gain access to the huge communication potential of the various submarine landing cables with tens of terabytes capacity.

The strategic deployment and implementation of a teleport hub serves as an African convergence port, where the terrestrial fiber can connect and merge with the Communication Satellite Network.





Nigcomsat-1R Services, Solutions & Applications

IDIRECT

HUB SYSTEM:

IDX 3.0 ON DVB-S2

NEWTEC SAT3PLAY BROADBAND GATEWAY SYSTEM

with differentiated classes of services

Services, Solutions & Applications

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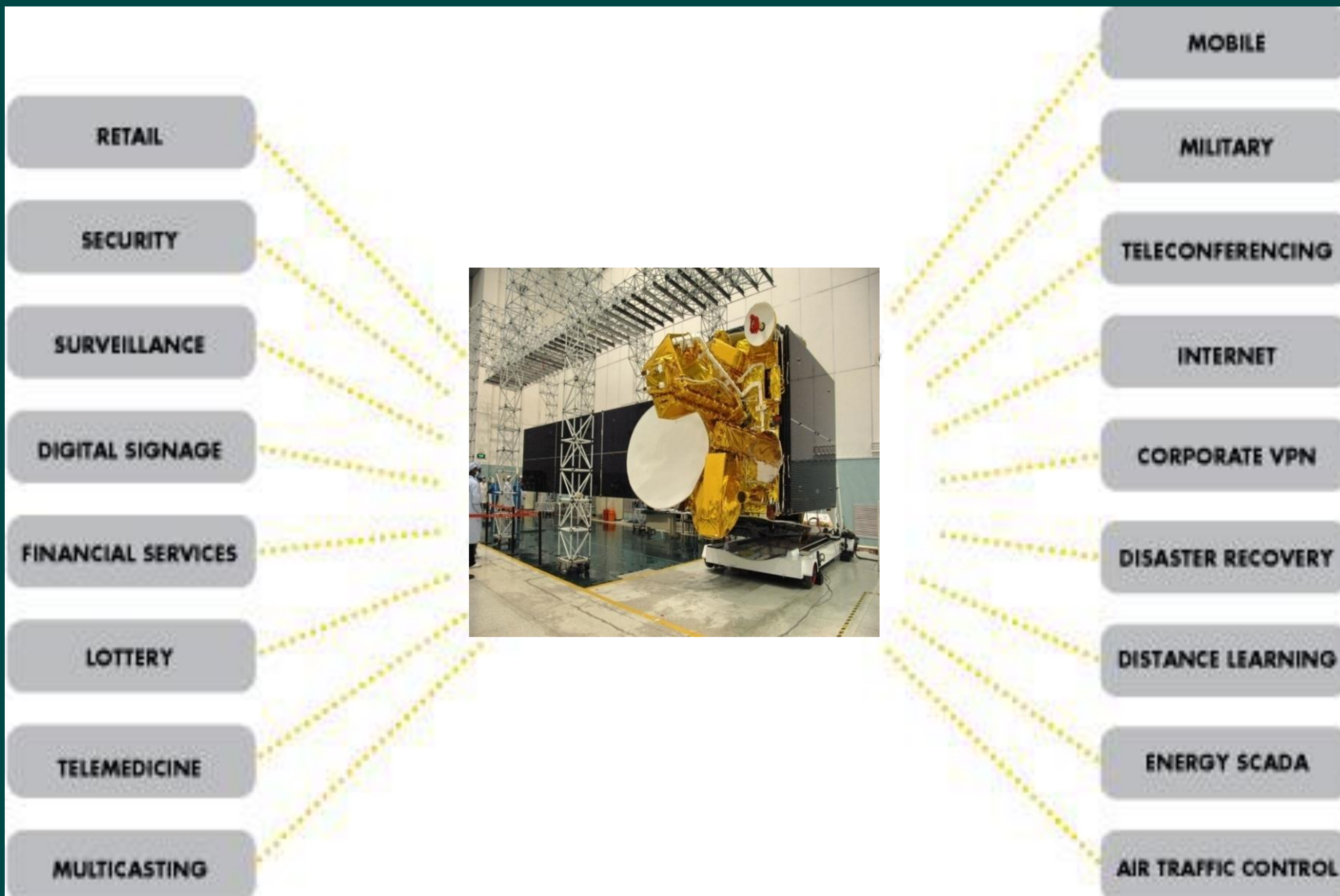

Services, Solutions & Applications

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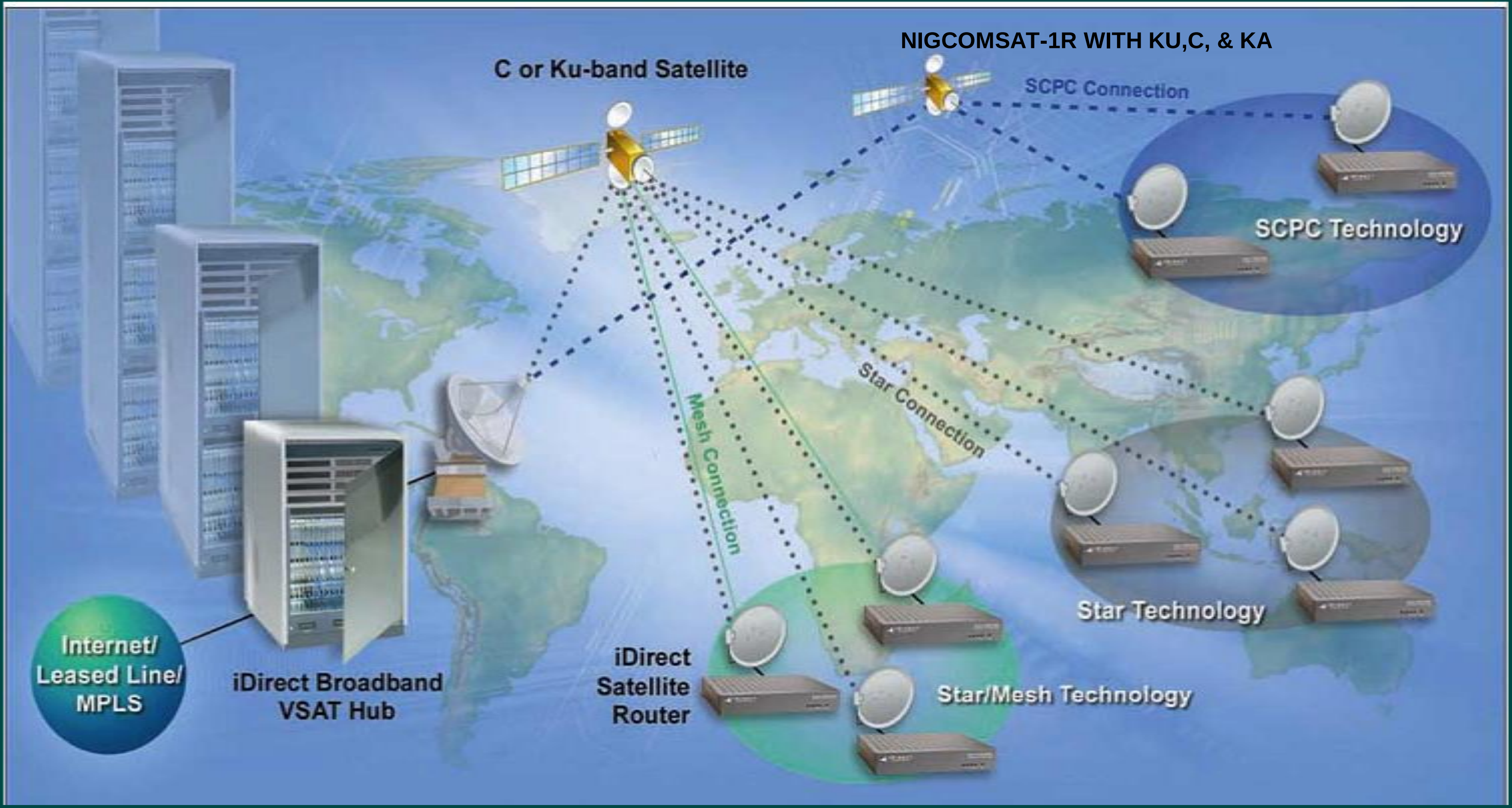

Nigcomsat-1R Services, Solutions & Applications

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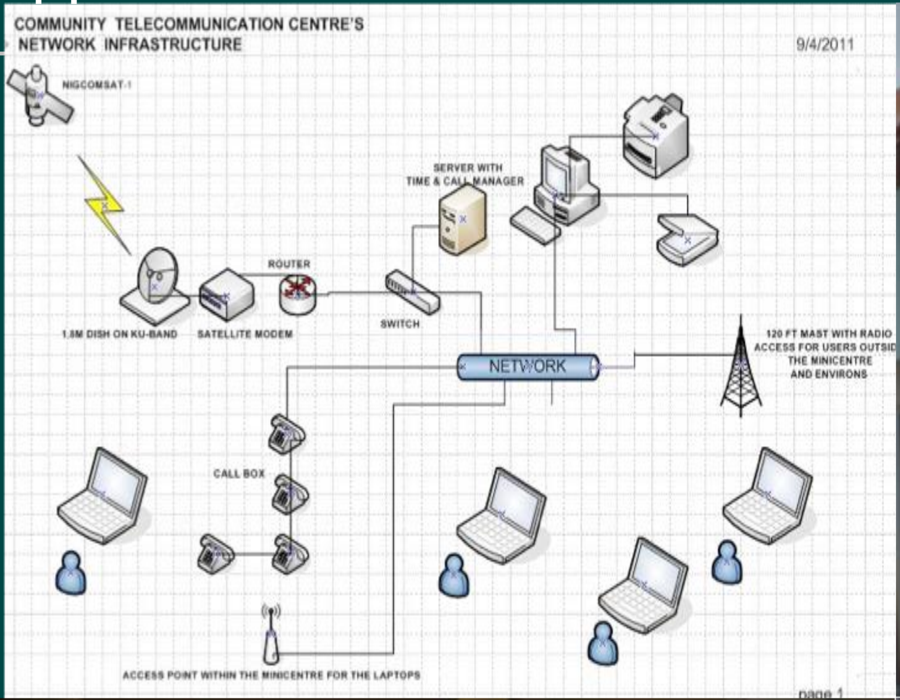

Broadband Applications

51 Broadband has the potential to enable entire new industries and to change how we educate our children, deliver health-care, enhance farming, ensure public safety, engage government, and access, organize and disseminate knowledge.

Tele Medicine

Tele Education

Agriculture

E-Government

Public Safety and Security

Financial Inclusion Strategies

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For existing POS Terminals with Ethernet and WIFI communication options:

System Engineering Solution: 3G USB Dongle +3G/4G Wireless Routers

Challenges of satellite broadband

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- High cost of ComSat Resource (Transponders): Newer generation of satellite; HTS aggressively addresses cost.
- Back-up Communication Satellite to ensure and guarantee service continuity for service providers that operate a lone communication satellite.
- Two more satellites are planned

National ICT Broadband Infrastructure Fibre Optic Backbone (NICTBB) Tanzania

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NICTTB is connected internationally to the SEACOM undersea cable and the Eastern African Sub-Marine cable System (EASSy),

Tanzanian National ICT broadband backbone (NICTBB) 10,000 km of DWDM

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- NICTBB network is delivering e-services such as:
  - e-Money, e-Commerce, e-Banking, e-Education and e-Government in both the public and private sectors and also in rural areas
- NICTBB operates as the wholesale business concentrating on large capacity interface of high-speed data streams i.e. Synchronous Transport Module-STM-1 (155 Mb/s), STM-4 (622 Mb/s), STM-16 (2.4 Gb/s), and STM-64 (10 Gb/s) to telecomm operators
- In Rural areas, the last mile of communications is still a cost issue

Tanzanian National ICT broadband backbone (NICTBB)

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- NICTBB is implemented on three network technologies: Dense wavelength division multiplexing (DWDM), Synchronous digital hierarchy (SDH) and Internet protocol (IP)

- NICTBB has adapted the transmission of IP over SDH over DWDM, in which IP packets (i.e. Internet traffic) are encapsulated and then transmitted by a router with either fast Ethernet (FE) or giga Ethernet (GE) port directly over SDH then to the DWDM optical layer

Tanzanian National ICT broadband backbone (NICTBB)

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- DWDM network incorporated into NICTBB supports 40 wavelengths per fibre and each wavelength can carry 10 Gb/s; thus enabling a single fibre to carry four hundred gigabits/s (400GB/s) of data

- Following NICTTB being connected internationally to the SEACOM undersea cable and the Eastern African Sub-Marine cable System (EASSy), the International bandwidth cost reduced dramatically from $1,500 per Mbps to $180 per Mbps that is equivalent to an eighty eight percent [88%] reduction.

NICTBB Pricing (US$), 2010

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Service	Annual Price (US$)	Annual E1 (2.048Mbps) Price (US$)	Monthly E1 (2.048Mbps) Price (US$)
STM - 1	180,000.00	2857.14	238.10
STM - 4	432,000.00	1714.29	142.86
STM - 16	1,036,800.00	1028.57	85.71
STM - 64	2,488,320.00	617.14	51.43

Internet bandwidth monthly tariff rates for both commercial and residential [Source: TTCL] Tanzania

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Internet tariffs for Retail Residential Market		Dec 2009	Dec 2010	Dec 2011	Change
Broadband 1GB	N/A	$ 18.57	N/A	N/A	
Broadband 2GB	$ 61.90	$ 37.14	$ 18.57	$ 18.57	-70%
Broadband 4GB	$ 123.80	$ 61.90	$ 37.14	$ 37.14	-70%
Internet tariffs for Retail SME Market					
Broadband 20GB	$ 278.55	$ 222.84	$ 123.80	$ 123.80	-56%
Broadband 40GB	$ 619.00	$ 278.55	$ 222.84	$ 222.84	-64%
Broadband 80GB	N/A	N/A	$ 278.55	$ 278.55	
Internet tariffs for Retail Corporate Market					
Dedicated 512Kbps	$ 3466.40	$ 1374.18	$ 705.66	$ 705.66	-80%
Dedicated 1024Kbps (1Mbps)	$ 5694.81	$ 1943.66	$ 1163.72	$ 1163.72	-80%
Dedicated 2048 (2Mbps)	$ 7675.61	$ 2896.92	$ 2240.78	$ 2240.78	-71%
MPLS VPN tariffs for corporate Market					
MPS VPN 256Kbps	$ 800.00	$ 800.00	$ 800.00	$ 350.00	-56%
MPLS VPN 512Kbps	$ 1,500.00	$ 1,050.00	$ 1,050.00	$ 480.00	-68%
MPLS VPN 1024Kbps (1Mbps)	$ 2,500.00	$ 2,040.00	$ 2,040.00	$ 720.00	-71%

Conclusions

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- The success of Africa’s information technology policy and infrastructure in the short and medium term remains wireless systems (space and terrestrially based).
- Satellite communications have a competitive advantage as they complement the present sparsely distributed terrestrial links.
- In broadcasting sector, satellite digital television complements terrestrial television and offers an alternative to digital terrestrial television.

Conclusions

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- Communication satellites are strategic continental ICT infrastructure with far reaching impacts in enhancing telecommunications, broadcasting, the internet, multimedia services and emergency & disaster management. Short lead time.

- Intra-city and inter-city metro ring optic fibers built in and around Africa are ultimately desirable for sustainable broadband experience as a long term plan. Long lead time.

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